ANNUAL REPORT 1982

ONTARIO RESEARCH FOUNDATION

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The covers of this document contain the names of less than half of the 2,100 Canadian industrial clients served by ORF in 1982.

As Chairman of the Ontario Research Foundation's Board of Governors and as an individual whose prime interest is in technology and innovation, I was extremely pleased to see that despite the economic trauma of 1982, ORF, for the third consecutive year, served more than 2,000 Canadian industrial clients.

This, coupled with the breadth of ORF's client base, proves, more than any other available statistic, the worth of this organization. For it proves that Ontario is building a solid infrastructure of small manufacturers and innovative companies, many of whom are in need of technological services. And it proves that Ontario Research is responding to this perceived market by expanding and tailoring its capabilities to meet those needs, and to help those companies grow.

The level and scope of applied industrial research, as offered by ORF, then, is a commodity to which Canada's manufacturing and industrial sectors must turn more and more in the near future if Canada, and especially this Province, wants to establish the technological base which will make it competitive in today's market place.

Donald Chisholm

Report of the President

The past year, 1982, has been one of severe economic stress for Canadian industry and so for our industrial customers and, as a result, for the Ontario Research Foundation. In reviewing the performance of Ontario Research it is clear that our industrial activities were adversely affected and the growth of these activities, characteristic of our operations for the past three decades, ground to a halt. Nevertheless, on balance Ontario Research responded to the challenge of the recession with a considerable degree of success.

The past year was one of only modest growth. Our income of $18,447,000 was 10% higher than that of 1981. Declining demand for services forced us to reduce staff from 443 to 382. Despite this regrettable decline in staff, and despite the stringent measures taken to meet the challenge of the recession, we were unable to meet our total expenses of $18,769,000. Consequently, we had an operating loss of $332,701—1.7% of total income. Viewed from a different perspective, Ontario Research met all its out-of-pocket costs and, in addition, covered $1,520,000 of depreciation charges.

Income from services for industrial clients amounted to $8,157,000, only 3% higher than that of 1981. Even so, we provided technical services to over 2,100 industrial firms. On the other hand, income from the Federal Government increased substantially to $4,045,000. This shift in income pattern from industry to government is at variance with our main purpose of providing services to the industrial sector, but was necessary if we were to maintain staff and capabilities in the deteriorating economic climate. Although, despite our very best efforts, we failed to balance income and expenditure; I must express my deep appreciation and admiration for the manner in which the staff responded to the extraordinary challenge of the recession.

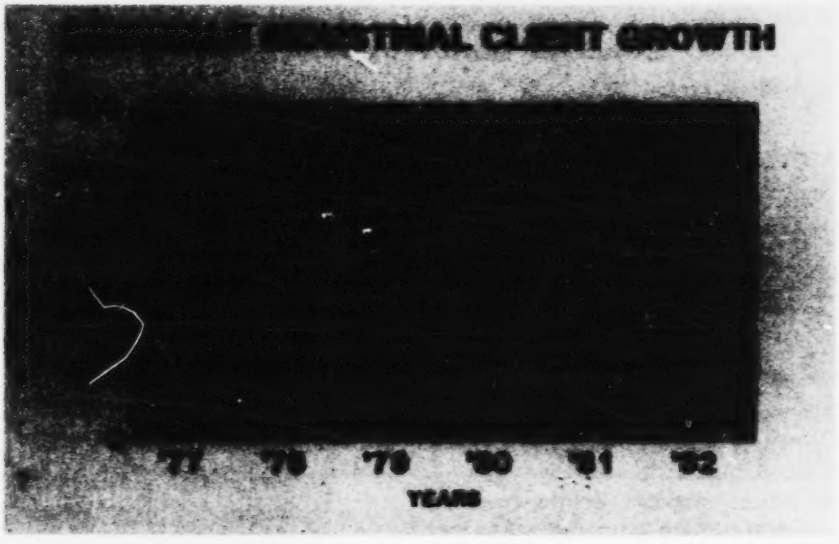
The importance of the Performance Grant provided by the Ministry of Industry and Trade to the continuing success of Ontario Research cannot be overemphasized. For fiscal 1982-83 the grant totalled $4,750,000—an increase of $530,000 over that for 1981-82. Of this amount $500,000 was made available at mid-year to meet urgent needs for scientific equipment. In large measure these increases allowed Ontario Research to maintain capabilities in those core areas most severely hit by the economic downturn.

While the recession of 1982 has sharply focussed attention on problems of employment and productivity, we must not lose sight of the structural changes that are occurring in the economy of all industrial nations with the emergence of the post-industrial economy. We are undoubtedly facing profound changes in the way industry uses labour, materials and capital and in the very manufacturing processes themselves. The post-industrial economy will see a decline of the importance of manufacturing employment in the labour force parallelling that of agriculture from the turn of the century to the present. The similar trend in manufacturing will be accelerated by the ever increasing automation of manufacturing brought about by the computer and the micro processor. As with agriculture, this does not mean that manufacturing will be of less importance to our economy, but simply that we will be able to make more and more goods with less and less people.

The downtrend in the use of labour in manufacturing appears to be repeated in the use of materials. For example, it has been pointed out that the average car weight has been reduced from 3,900 lb. in 1977 to 2,700 lb. in 1982 with further significant decreases forecast over the next few years. Here too, the trend is accelerated by the all pervasive micro processor which permits more sophisticated design and saves raw materials as well as labour.

Another trend of the post-industrial society, although less well noted, has been the rise of small business. John Kettle has noted that the actual number of new jobs created has been larger in small firms than in large,—of the 1,970,000 jobs created in the Canadian economy since 1971, 56.7% are in small businesses. The predominance of the small firm in new job creation has been noted in manufacturing as well. Norman MacRae in The Economist shows that, in manufacturing in the United States and Great Britain, those firms with 200 employees or less have actually shown an average annual increase in employment, while the larger firms with over 200 employees have shown an actual decrease.

Just as these emerging trends of the post-industrial society will profoundly affect our industry, so will they profoundly affect

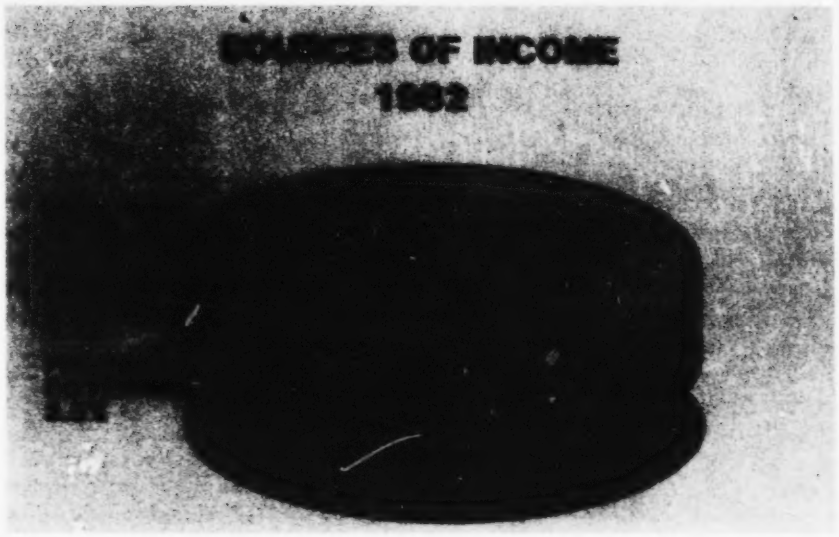


activities at Ontario Research. The trend to ever increasing automation portends increasing demand for our services in the field of computer aided design and computer aided manufacturing. The Ministry of Industry and Trade, in order to accelerate this move to automation, has created the Ontario Centres for Advanced Manufacturing with Cambridge specializing in CAD/CAM and Peterborough in robotics. Ontario Research will strengthen its capabilities in these fields and anticipates working closely with these centres to accelerate the automation of our manufacturing industries.

Ontario Research is extremely well positioned to provide assistance to industry in the more effective use of materials. Ontario Research has a long and broad experience with the whole spectrum of materials from metals and ceramics to organics and composites and an enviable track record in the development of specialty materials for specific purposes. The trend to the more effective use of materials ensures that our capabilities in this broad field will be called upon increasingly in the years ahead.

With respect to the rise of small business, Ontario Research is also well positioned. The provision of technological services to the medium and small enterprise has been the central thrust of Ontario Research for many years. Of our 2,100 industrial clients, about half are companies with less than 100 employees and 70% with less than 300 employees. About 50% of our industrial income is derived from firms with less than 300 employees. With the rising importance of small business as job creators in the Ontario economy we will be emphasizing the delivery of seminars and training courses that are particularly designed to meet the needs of the small firm. Our present program, directed toward companies with less than 200 employees, is particularly pertinent to those firms who do not have staff with formal training in production management techniques. The program will be expanded in 1983.

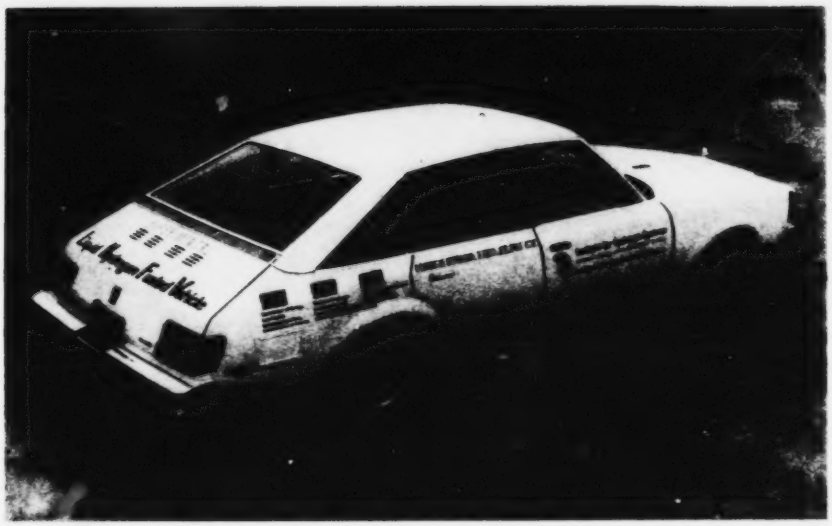
To sum up, Ontario Research met the recession of 1982 with reasonable success. At the end of the year, the first faint glim-



merings of recovery were appearing on the horizon. Our experience in 1982 will serve us well through the slow and painful recovery generally predicted for 1983. However, more importantly, we must continue to position ourselves so as to meet successfully the more important long term trends of the emerging post-industrial economy.

W. R. Stadelman

Energy



Studies continued on the potentials of hydrogen as a fuel for use in transportation systems

Projects in the energy field covered a wide variety of activities ranging from the development of blended fuel mixtures in internal combustion engines to the evaluation of insulated building components.

Energy Conservation

A major program directed toward energy conservation in commercial grain-drying systems was initiated on behalf of Agriculture Canada. As a first step, the energy requirements of a 100,000 bushel/hour grain dryer were established by instrumenting and monitoring the unit under normal operation. The data obtained are now being analyzed and used to design a thermally optimized heat recovery system to be retrofitted during the spring of 1983. Monitoring will be continued during the 1983 drying season, following which results will be compared with the original system.

Also on behalf of Agriculture Canada, a multi-year program was initiated to evaluate a new type of greenhouse heating system, conceptually developed in 1981. The system collects and stores solar energy in an underground water tank during daylight hours. At night the stored heat is pumped back into the greenhouse to provide a major portion of the heating requirements.

During 1982, the system was designed and installed in a newly constructed commercial greenhouse in Leamington, Ontario. This new greenhouse incorporates a number of retrofit energy-conservation measures and other features, such as CO_2 enrichment and humidity controls. Computerized data acquisition and feedback control systems were installed to continuously monitor energy consumption and control the growing environment. For comparisons, an adjacent greenhouse, with a conventional steam-heating system, was instrumented and will also be monitored during the three-year study

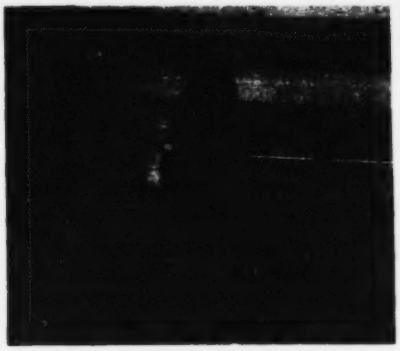
On behalf of the National Research Council a program was initiated to monitor a well-water-source residential heat pump system. Monitoring methodology and instrumentation were devised and the necessary equipment was installed in a single family residence. The study will be completed in the fall of 1983 at which time the results will be used to determine the seasonal heating contribution provided by the heat pump system. In addition, the data will be useful for establishing performance criteria for such systems and to identify operating limitations.

For VIA Rail Canada Inc., an investigation was undertaken on opportunities for energy conservation in passenger train heating, ventilation and air conditioning systems. In the first phase of this project, extensive operational, performance and maintenance data on passenger train HVAC systems were compiled and analysed. A comparative energy consumption analysis was performed between existing steam heating systems and alternate electric heating systems. This led to the design of a new high efficiency steam heating system. The proposed system is fully compatible with existing rolling stock and offers extensive advantages in terms of energy efficiency, reliability and maintenance costs.

During 1982, construction of a guarded hot box for the Building Performance Centre was completed, and commissioning and calibration trials were begun. Tests were performed to correlate measured results with results obtained by the National Research Council, an established authority in the field of thermal measurement. Heat flows in windows is expected to be an area of great interest, since windows account for a significant amount of heat loss in a building. Many research programs are underway to improve window design, framing details, and glazing efficiency.

In a program being conducted for the Ontario Ministry of Municipal Affairs and Housing, a comprehensive state-of-the-art study was completed on factors affecting energy flows through windows. A comparative rating procedure was developed for various commercially available window glazings and types of window-insulating devices. This study was designed to provide the Ministry with information that it could use to help the average consumer choose the most appropriate product for specific needs.

The guarded hot box facility can also be used for the determination of heat flow characteristics through walls, etc. Special problems occur in walls that have highly conductive bridging members, such as



ORF's new guarded hot box facility is used primarily for the determination of heat flow characteristics through walls.

sheet steel walls with steel bridging supports. In these cases mathematical models do not predict the net heat flow accurately, and actual testing is the only means by which accurate results can be obtained. While the guarded hot box is at present used largely for testing purposes, its greatest potential lies in its use as a research tool.

Solar Energy Systems

A project was undertaken for NRC to evaluate the testing of solar cells using the solar simulator at the NRC National Solar Test Facility (NSTF), including the design and construction of equipment to measure the current-voltage characteristics and the spectral response of solar cells.

It was demonstrated theoretically that the NSTF solar simulator would be suitable for testing modules assembled from single-crystal silicon cells when using a precalibrated reference cell of the same type. This was verified experimentally by comparing current-voltage with measurements obtained with the simulator and with measurements made by the Jet Propulsion Laboratory, Pasadena, California. Two solar cell modules and three reference cells were exchanged for this comparison and agreement was found to be within 2%.

A contract awarded in 1981 to develop methods of testing solar domestic hot water (SDHW) systems was completed in the spring of 1982. The work included conducting ORF's first indoor thermal performance tests on two Canadian-made SDHW systems, using the advanced Vortek solar simulator in the National Solar Test Facility to produce a "Standard Day" of solar radiation. Recommendations were made on comprehensive, yet practical, procedures for performance and functional tests which have been included in a preliminary testing and rating standard, prepared by the Canadian Standards Association.

During 1982 ORF was contracted by the National Research Council to build the equipment necessary to test SDHW systems to this standard, and to use this equipment to evaluate the test procedures contained therein. This work has included the design and construction of a computer-controlled heater capable of simulating the performance of a solar collector array of up to 15 square metres in size, and the modification of the Vortek lamp control system to enable the computer performing the tests to automatically adjust and maintain the hourly radiation levels of the "Standard Day".

Alternate Fuels

Despite the current over-production of oil from world suppliers there is a continuing need to find alternative and renewable sources of energy to replace or extend the world's rapidly diminishing oil resources. On-going programs during 1982 covered engine development and the field testing of vehicles operating on alternative fuels such as propane, alcohols, and hydrogen.

An improved propane conversion kit for spark ignition engines was developed for Vapro Automobile Systems Inc. This kit should improve the cold weather operation of propane-powered vehicles. Also some concepts for propane/diesel substitution were investigated and developed under a grant from the Ontario Ministry of Industry and Trade.

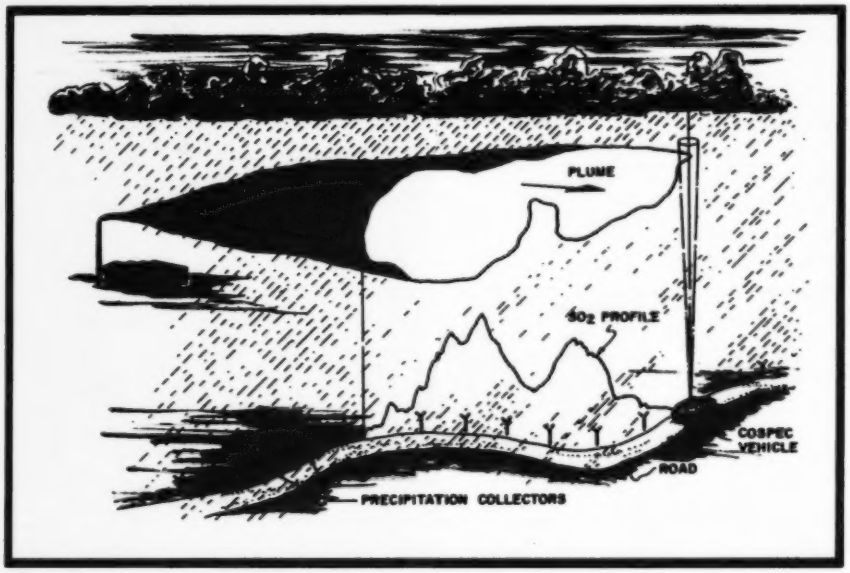
On behalf of Celanese Canada Inc., in a joint program with the Ontario Ministry of Energy, and Energy, Mines and Resources, field testing of 4.75% methanol/gasoline blends, using iso-butyl alcohol as a cosolvent, was commenced during the year. Driveability assessment in cold weather, and materials assessment after high mileage accumulation are major features of this program. In another study, this one undertaken on behalf of Transport Canada, vehicles equipped with an ORF-developed phase-separation control system, were tested on 20% methanol/gasoline blends. In addition, a new program was initiated for Transport Canada on the testing of 100% methanol-fuelled cars.

Another series of projects involved alcohol substitution in diesel fuels. Using a fumigation approach with a Cummins diesel, programs involving partial substituion of methanol were continued on behalf of Noval Technologies Ltd. For INCO Ltd., similar work was undertaken using an emulsification approach with a Deutz diesel engine. Also, work on ethanol and canola oil substitution in a Perkins engine for farm tractor use commenced for Agriculture Canada.

Studies continued on the potential of hydrogen as a fuel for use in transportation systems. The possibility of using hydrogen generated from liquid carriers, such as methanol or ammonia, using engine waste heat, was evaluated. Another project is being planned with the Ontario Institute for Hydrogen Systems and is concerned with the use of liquid hydrogen as a fuel for transportation systems.

For VIA Rail Canada Inc., an investigation was undertaken on opportunities for energy conservation in passenger train heating, ventilation and air conditioning systems.

Environment



A new approach to reliably define plume behaviour and location during any specific precipitation event was developed.

In spite of the downturn in the economy, environmental issues continued to be of concern. Our work for government agencies placed particular emphasis on problems related to health hazards in the workplace and in the home.

Long-Range Transport of Pollutants

At both political and scientific levels debate continues over the transport and deposition of acidic air-borne products resulting from industrial and other emissions discharged to the atmosphere. A new approach to reliably define plume behaviour and location during any specific precipitation event was developed under contract with the Ontario Ministry of the Environment. Coupled with an analytical procedure to determine the constituents washed out of such plumes by rainfall, a better understanding of both the plume washout phenomena and the geographical extent and impact of major pollutant sources has been achieved.

Acid deposition is believed to result primarily from man-made emissions of sulphur and nitrogen oxides. Over a larger geographical area, however, it is difficult to relate observed environmental degradation to specific sources without accurate information on source location, type of emissions and emission rate. To this end, an inventory of primary sulphates within Canada was completed for Environment Canada, to determine both the total and acidic fraction of these pollutants for the base year 1978.

Also, as part of the acidic precipitation in Ontario study being undertaken by the Ontario Ministry of the Environment, a detailed inventory of area source NO_x emission in Ontario is underway.

Waste Treatment

Installation of the first commercial Wetox® unit, by Wetcom Engineering Limited, at Uniroyal Chemical in Elmira, Ontario, was nearing completion at year end. This unit, which will come on stream early in 1983, has an operating capacity to treat up to 14,000 gallons per day of mixed organic wastes. Uniroyal will benefit from major savings in waste transportation and disposal fees, plus utilizing the recovered heat elsewhere in the plant.

During the year a number of short-term investigations were undertaken for clients in industries such as pulp and paper, nuclear, and electro-plating, to assess the applicability of the Wetox process to their particular waste destruction and resource recovery problems. One of the small ORF Wetox reactors was converted from semi-batch to continuous flow operation.

Under new provincial regulations expected to be fully implemented by 1984, virtually every waste that is produced and hauled away from its source will be subject to specific handling procedures. Toxic or hazardous wastes are a prime consideration. ORF is participating in several studies to delineate criteria for the identification of hazardous wastes generated in the province. In addition, the identification and assessment of generic processes and/or waste reduction practices, for toxic and hazardous wastes has been carried out.

Several industries have been given assistance regarding toxic and hazardous wastes, such as cyanides, phthalates and phenolic compounds. Also, in-plant surveys have been conducted to characterize sources of wastes and to identify appropriate remedial measures, such as waste reduction treatments, recycling, etc. By adopting recommended changes in processes and operation, some clients have accomplished over 90% reduction in toxic waste generation. ORF operates the Canadian Waste Materials Exchange which coordinates the use of one company's wastes as substitute raw materials in another company. In addition, through its pilot scale facilities, ORF has developed several new and cost-effective waste treatment and destruction technologies and applications.

Municipal and industrial landfill monitoring and modelling for toxic chemical migration and methods for the improvement of landfill operation are other areas of active R & D at the ORF.

Occupational and Environmental Health

In all industrialized societies public concern over the quality of the environment

and the health of the individual has led to various legislated regulations aimed at controlling or improving the quality of air, water and other aspects of the environment. These concerns apply to specific workplaces as well as to the general environment.

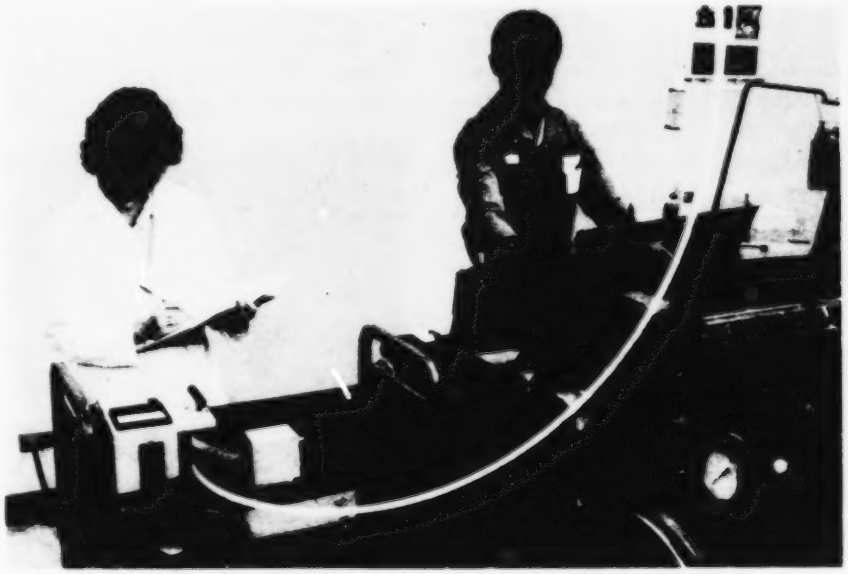
The possible biological effects of chemicals is one such concern. Of prime importance are the genotoxic effects, particularly the ability of certain chemicals to cause cancer. In response to this concern, tests have been developed for rapidly and economically detecting and identifying chemical carcinogens. The best known of the first stage short-term bio assay tests for the detection of mutagens/carcinogens is the bacterial assay developed by Dr. Bruce Ames and co-workers in California. At ORF the Ames mutagenicity test has been used in the evaluation of many industrial situations. One example is its application in exhaust emission-control programs where diesel engines are used underground in mining operations. In this instance the evaluation of emission-control methods or devices should be based not only on the desired reduction of a specific pollutant but also on the effect that these methods have on the entire exhaust. By using specially developed sampling techniques we have been able to demonstrate the effectiveness of various emission-control devices under both laboratory and field conditions, with respect to the corresponding changes in mutagenicity in the particulate fraction. We have also used the Ames test in studies of drinking waters, in the development of control technology for industrial effluents, such as pulp and paper mill effluents, and for the assessment of new organic chemicals. In the case of the pulp and paper studies it was demonstrated that modifications to certain pulping and bleaching parameters can considerably reduce mutagenic response in the effluents.

Under contract to the Royal Commission on Asbestos, current and possible future measurement methods for the determination of air-borne asbestos concentrations in workplaces were reviewed and evaluated. Instrumental measurement methods and fibre counting techniques were included in this study. The basic requirements of the measurement were established and the ability of current methods to meet these requirements was discussed. The objective of workplace air monitoring is to determine the concentration of respirable asbestos fibres in the air, and to identify which type or types of asbestos are present. In Ontario, and most jurisdictions in Canada and other countries, the measurement is currently obtained by using an optical microscope and counting the fibres deposited on a membrane filter through which air has been drawn to collect the dust. Because of the subjective factors in fibre counting, and differences between equipment and practices in different laboratories, a single sample can yield quite different results, particularly when the air-borne fibre concentration is low. A number of changes to the currently adopted Ontario Ministry of Labour measurement method were recommended to improve the accuracy of the measurement. Discrimination of specific asbestos types was also studied.

Some future developments in measurement of air-borne asbestos in workplace atmospheres appear promising. However, it was concluded that the basic principles of the membrane filter method will probably remain as the preferred method for routine monitoring in the immediate future. The final report on this investigation has been published by the Royal Commission on Asbestos as Study No. 9, entitled "Measurement of Asbestos Fibre Concentrations in Workplace Atmospheres".

A complementary study undertaken on behalf of the Department of Health and Welfare has resulted in the development of a computer-based automated fibre counting system using a scanning electron microscope to analyze air samples from the workplace environment. The major problem found with any fibre counting instrument based on image analysis is the counting of fibres that overlap one another in the image. The developed image analysis system has now been modified to address the fibre counting problem, specifically the enumeration and classification of fibrous particulate in the workplace atmosphere.

Another aspect of the same contract



Current and possible future measurement methods for the determination of air-borne asbestos concentrations in the workplace were reviewed and evaluated.

Environment.....cont.

Field programs were carried out to evaluate the effectiveness of specific remedial measures intended to reduce the concentration of formaldehyde in the living spaces of masonry houses insulated with urea-formaldehyde foam insulation (UFFI).

was the development of an instrument capable of automatically determining the asbestos fibre content in workplace air without the use of an optical or electron microscope. The technique being developed is based on the alignment properties of asbestos fibres in strong magnetic fields. The system has been developed to the point where it can be used routinely for measuring the light scattered from magnetically aligned asbestos fibres.

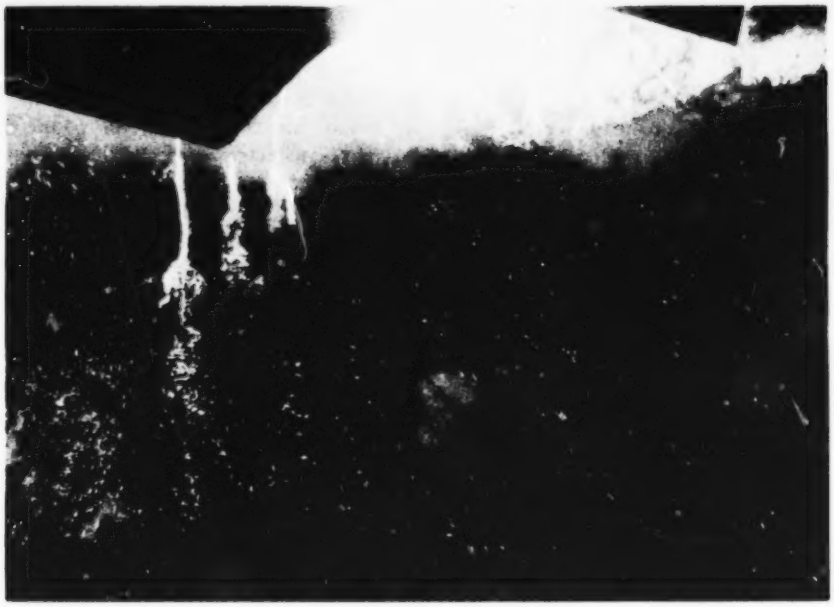
On behalf of the National Research Council of Canada (NRC) four field programs were carried out to evaluate the effectiveness of specific remedial measures intended to reduce the concentration of formaldehyde in the living space of masonry houses insulated with urea-formaldehyde foam insulation (UFFI). In one house the interior faces of the outside walls were sealed to prevent entry of formaldehyde; another house was similarly sealed and then pressurized to further reduce infiltration. In a third house, the sealing was combined with the installation of an air-to-air heat exchanger to introduce fresh air while exhausting the contaminated air. The fourth program involved an evaluation of the effectiveness of filter/scrubber devices to purify contaminated air. The house characteristics (air leakage rate, etc.) were thoroughly documented before and after the remedial action and, from the data obtained, the effectiveness and cost benefits of the remedial actions were determined.

At ORF the Ames mutagenicity test has been used in the evaluation of many industrial situations.

Where the formaldehyde concentration cannot be controlled by such remedial measures, removal of the UFFI is often the only recourse. Another program, conducted on behalf of NRC, involved the investigation of several techniques that might allow the removal of UFFI from masonry walls without completely dismantling the wall. Varying degrees of effectiveness of the techniques were observed. A laboratory program was also undertaken to investigate alternative chemical treatments for cavities from which UFFI had been removed, and to develop a procedure for determining the permeability of building materials to formaldehyde gas.

Several independent investigations of commercial buildings were also carried out on behalf of building owners and managers. In these investigations, site inspections were conducted to determine the extent of use of UFFI, the effects of the UFFI on building elements (such as corrosion of metal components), and the concentration of formaldehyde in the inhabited space. Recommendations were made for corrective or remedial action where warranted.

Materials



One project related to the utilization of blast furnace slag for the production of abrasion resistant glass-ceramics

Assistance to industry in the development and application of materials represents a particular strength of Ontario Research. Projects undertaken during the year ranged from studies of the fatigue and fracture properties of steels to the development of biocompatible materials for human implants.

Building Materials

ORF is continuously involved in activities covering a wide range of building materials. One such activity undertaken in 1982 related to the development of thick protective coatings. Conventional protective coatings, whether applied by brush, roller, or spray, are usually deposited in a layer about 1 mil to 6 mils thick when in the wet state. During the drying process the film thickness reduces to about 0.5 mils to 3 mils, depending on the solids content of the coating material. When thicker coatings are required, it is necessary to apply multiple coats, and to allow for a drying time between coats which varies depending on the type of coating.

Over the last few years a number of specialty water-based coatings, described as "Thick Coatings", have been developed. These new coating formulations permit the application of a much thicker wet coating than is possible with conventional materials, resulting in a much higher dry film thickness. With these materials a dry film thickness of 10 mils to 15 mils can be applied in one coat, often with drying times no longer than with conventional solvent-based coatings. Thick coatings are finding uses in both exterior as well as interior applications, on both vertical as well as horizontal surfaces, as protective coatings as well as for cosmetic purposes. At ORF a special thick coating has been developed specifically for encapsulating asbestos insulation and similar materials; this formulation is expected to be available commercially in the near future. Also, work is currently underway on the development of special thick coatings for other specific applications.

Specialty Materials

In the area of glass and ceramics materials a number of projects involving traditional as well as high-technology activities were undertaken. One project, under the auspices of NRC, involved a study into materials and processes used in the manufacture of ceramic molds for precision casting of metals; the aim of the research was to improve quality and production costs. In another program, assistance was provided to Chromalox Canada, Inc. toward the development of high capacity heat storage systems that could utilize off-peak electrical power loads. Also, on behalf of Quality Hermetics Company, glass-ceramic-to-metal seal compositions were developed for use in deep drilling operations.

An interesting new area of activity involved the evaluation of the feasibility of storing hydrogen in glass micro-capsules. This program, carried out with the support of NRC, is an example of a high-technology area with applications in the transportation sector. Another project with potential high-technology applications involved the use of spray technology to produce coatings that would improve the abrasion resistance of softer substrate materials; this work was undertaken for the Department of Energy, Mines and Resources.

Another EMR-sponsored project related to the utilization of blast furnace slag for the production of abrasion resistant glass-ceramics. The materials developed have applications in the building and construction industry. Other studies related to the behaviour of glass panels under different wind load conditions, and a non-destructive testing program for the detection and characterization of flaws in high performance ceramics.

A long-term study, undertaken on behalf of NRC and aimed at establishing the relationship between structure and properties of lead-based glass compositions, was continued. The results of the study will support the Canadian pottery industry in formulating glaze compositions with improv-

ed environmental safety characteristics.

During the year a state-of-the-art assessment of Rapid Solidification Technology (RST) was made on behalf of the Defence Research Establishment. RST is a novel way of making high-strength and corrosion-resistant materials by solidifying molten alloys very rapidly, and processing the solidified material. The materials also possess some unique properties not found in the conventional alloys. Because of their unusual mechanical, magnetic, electrical and corrosion-resistant properties, these materials are being considered for numerous applications, such as distribution transformer cores, aerospace structures, brazing ribbons, etc. To produce rapidly solidified alloys in the form of strips, ribbons, flakes and staples, meltspinning equipment was designed and fabricated at ORF. Using this equipment, microcrystalline alloys of iron and aluminum, and metallic glasses have been processed. The main effort is now focussed on the production, processing, characterization, and evaluation of aluminum-based alloys for naval and aerospace applications. In addition, some copper-based alloys are being studied for bearing and electrical applications.

Biomaterials

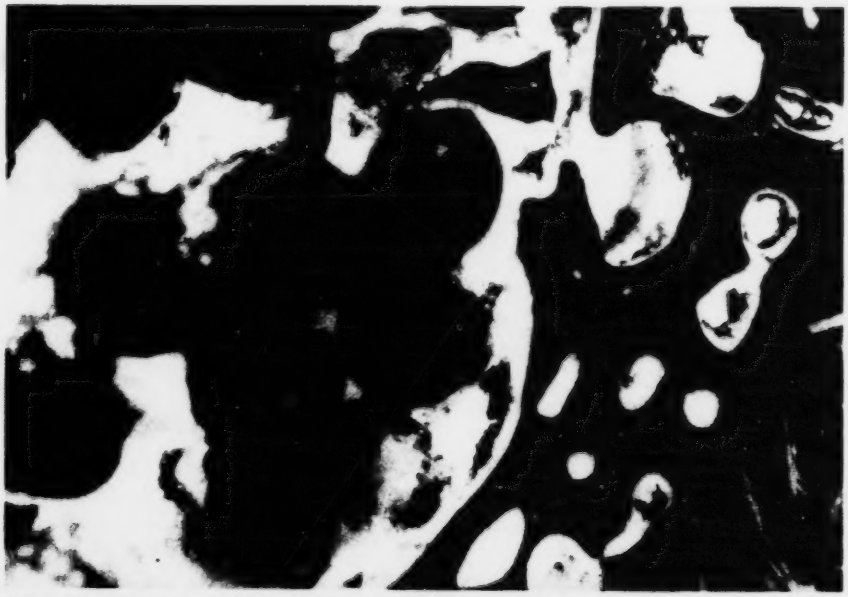
Work continued on the further development of porous plastic graft materials and on the novel process recently developed for the manufacture of vascular graft products from these materials. This new vascular graft fabrication technology should be applicable to the manufacture of products of various diameters for a variety of prosthetic situations, such as artery reconstruction, aortocoronary bypass grafts, hemodialysis shunts, etc. The preliminary in-vivo results are promising, and the fabrication technique allows design modifications which could prove to be major improvements. However, more experimental work needs to be done before clinical applications are considered.

With these materials, as with all materials that are used for vascular prostheses which have to interface with the bloodstream, the surface properties must allow long-term unrestricted passage of the blood as well as being biocompatible. In this regard, ORF has undertaken work, in cooperation with Dr. David MacGregor, a prominent Toronto surgeon, directed toward the development of porous metal surfaces as the bloodstream interface for prosthetic heart valves and, more recently, toward the development of porous polymers to interface with the bloodstream.

Bioglass represents a class of glass compositions that are biocompatible and are able, therefore, to achieve a direct chemical bond with bone. When applied as a coating to metallic implants, bioglass can act as a barrier to the release of metal ions that may be harmful to the body. To date, most attempts to coat metal implants with bioglass have not been completely successful because of poor adhesion. Special methods devised by the Biomaterials Group at ORF, however, have been successful in retaining both thin and thick coatings of bioglass on experimental implants made of cobalt-chrome alloys.

In these experiments, small cylindrical implants of glass-coated metal were placed in drilled holes in the lateral femoral cortex of dogs. Histological examination made at weekly intervals clearly revealed bone ingrowth adjacent to the coating within four weeks of implantation. These findings were encouraging and led to a speculation that a relatively thick coating of bioglass may enable biofixation by chemical as well as mechanical means under appropriate conditions of surface topography and chemistry. Such a composite implant might have an added advantage of easy removal should such a need arise after implantation. This is because the bioglass is inherently brittle, and intentional impact loading may permit the coating to break away from the metal substrate even though the bond strength is ordinarily sufficient for regular usage.

Another porous coating development at ORF has led to more effective heart pacer leads. The careful placement of heart pacer leads during surgery is often thwarted by a dislodgment which can occur after implantation. The new atrial and ventricular leads with porous-surfaced electrodes, developed by Cordis, however, reduces the frequency of such incidences. The technique of porous surface bonding to bone,



Micrograph showing bone ingrowth into bioglass-coated metal implant

originally developed for orthopaedic implants by the Biomaterials Group at ORF, was applied to pacer lead tips to promote tissue bonding. The ORF-developed porous Elgiloy metal surface is created by sintering thousands of minute spherical metal powder particles onto a metal substrate. Compared with uncoated tips, the surface area of a porous-surfaced tip is at least several times larger. The larger contact area also provides a more efficient means of converting the pacer output into the required ionic current. This leads to an increased efficiency since the resulting lower polarization impedance reduces the voltage required for the pacer output pulse. Efforts are continuing with the aim of applying porous surface technology to other types of heart pacer electrodes.

Metals

Steels, as the basic structural materials of engineering and construction, are often subjected to extremes of service conditions which, over the long term, can affect the integrity of the whole structure. In thermal power generation projects, for example, the combined forces of stress, temperature and aggressive environmental conditions can cause a small material defect in the steel to grow, threatening the integrity of the entire boiler structure. The study of fatigue and fracture resistance of steels thus forms a cornerstone of the metals properties testing laboratory at ORF.

Surface defects and cracks are often encountered in practice, but the fracture strength of a structural member containing such defects is an extremely complex function of stress, environment and material characteristics. To better understand these phenomena the growth behaviour of surface cracks was studied in a boiler grade steel plate under controlled conditions of tensile fatigue loading and elliptical crack geometry. The results show that the rate of crack growth is affected strongly by the stress ratio, indicating that high stress reversal is particularly damaging as opposed to the sustained application of high stresses. The relative shape of an elliptical crack remains constant regardless of the stress magnitude, however, enabling an estimation of the depth to be made from its length, measured on the plate surface.

Micrograph of boiler plate steel showing progressive elliptical cracks.

Fire and Flammability

Fire originating in a transit vehicle can represent a serious hazard to occupants if there is a possibility of rapid development of flame, heat, smoke and toxic gases. For VIA Rail Canada Inc., a project has been initiated involving a series of "arson scenario" tests on seating and mockup sections of their new LRC (light, rapid, comfortable) passenger car. The data derived from these tests will allow VIA to confirm those components and assemblies which yield the best possible fire-hardened vehicle.

As part of this project the current task is to construct a fire-resistive compartment, twelve foot long by ten foot wide by eight foot high, to simulate an interior section of the LRC car. The compartment is designed to admit air at floor level and to exhaust smoke and combustion gases through a duct at ceiling level. Instrumentation will include sampling probes for gas analysis, a smoke meter, heat flux meters, thermocouples for temperature monitoring and an anemometer for exhaust gas velocity measurement. Each mockup burn sequence will be recorded using video cameras. The burn compartment itself is located within a specially built, twenty-eight foot high, burn room equipped with an electro-static precipitator for smoke treatment.

Products & Processes

ORF has developed two processes for recovering useful papermaking fibres from such difficult waste papers as milk carton stock, strippable wallpaper and soft drink cartons.

The manufacturing industry is by far the largest contributor to Ontario's economy. Ontario Research plays a special role in assisting small to medium size companies in the development of new products and processes.

Pulp and Paper

The technology for recovering and re-using fibres from clean (unprinted) waste paper having no wet-strength additives or coatings is very simple. The recovery of printed paper, while more complex, is also feasible. However, the reclamation of waste paper containing polymers in the form of wet-strengthening agents, water repellents or coatings is very costly or even impossible using standard technology, and much of this type of material has, in the past, been dumped.

ORF has made a point of addressing this problem, and has now developed two processes for recovering useful papermaking fibres from such difficult wastes as milk carton stock, strippable wallpaper and soft drink cartons. One of the processes, a wet system, is now used on a regular basis by Atlantic Packaging Products Limited of Scarborough, Ontario, in their board mill.

The second process, which is the subject of ORF patents, is a dry system using disc-refiners to disintegrate the waste paper and produce fibres re-usable for paper making. In pilot-scale tests, paper containing up to 30% resin or plastic has been successfully reduced to a fibrous fluff, and re-formed into paper. The process has also proved to be highly efficient energywise, requiring 40% less energy per tonne of paper than a wet pulping process.

Textiles

In response to an increasing number of enquiries concerning the evaluation of insulated textile articles, the Textiles Department has set up a "Mewac" facility. The Mewac (Manikin Extreme Weather Apparel Comparator) is a recently developed system for evaluating the protection of apparel to extreme temperatures. It involves the use of a hollow manikin, within which heated air is circulated through a baffle system to ensure a controllable, even skin temperature. The manikin is covered with the test apparel and the temperatures, the power inputs to heaters and fans and other data are monitored until all the temperatures have reached a "steady state" condition. These power and temperature data are then used to calculate the insulation characteristics of the apparel.

At present, the system utilizes just the trunk and legs of the manikin, and has been used to evaluate the low temperature limit of use for sleeping bags. Other systems, based on similar principles, have been constructed to evaluate gloves and footwear, and it is intended to further develop the apparatus so that the hand and foot systems can be incorporated into the main unit. Eventually the Mewac test system will be able to offer a comprehensive cold weather apparel evaluation system for the whole of the apparel and footwear industries.

During the year, the Ontario Research shooting range saw considerable service in the evaluation of soft body armour. The testing apparatus permits a variety of types of ammunition to be accurately fired from guns that are held in a gun mount and triggered by remote control. Bullet velocity is determined by means of a chronograph which can measure time to one millisecond. Any bullet that passes through the test panel is checked on a second chronograph, downstream from the target. Ancillary equipment permits the hand loading of ammunition with the particular powder loads required to produce selected bullet velocities. Thus the range is used to carry out standard pass/fail tests in accordance with STD-0101.01 of the National Institute of Law Enforcement and Criminal Justice. It is used also in research studies to determine the "V_{50}" of a material—the velocity at which fifty per cent of the shots will penetrate and fifty percent will be stopped by the sample. During the year, the range was used both for manufacturers

who were working on the development of improved body armour and for purchasers as a quality control measure.

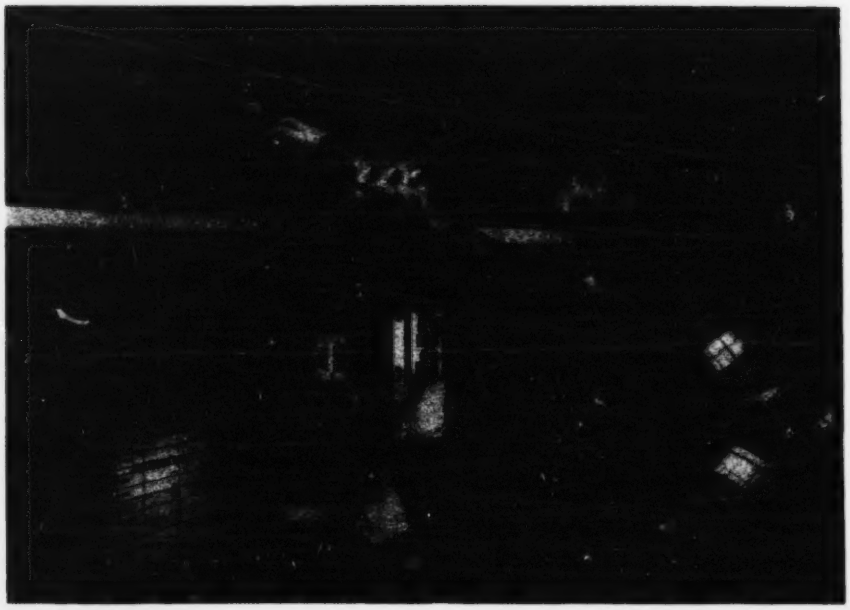
Microelectronics

Over the past several years, as a result of contracts involving the monitoring of solar energy and energy conservation projects, ORF has identified a requirement for low-cost energy meters for energy research. Commercially available units are not flexible enough for many of the applications encountered, and sophisticated data loggers were too complex and costly.

At ORF, several generations of hand-made devices have led to the design of a highly flexible energy meter specially suited for ORF's monitoring requirements. This meter has been made available to consultants and other commercial researchers now engaged in similar types of energy research.

ORF's familiarity with the instrument and understanding of the requirements of the end-user have made it possible to adapt this instrument to studies of heat pump and heat exchanger performance. Applications to photovoltaics, storage batteries and heat storage are contemplated.

The demonstrated capability of designing and constructing special instrumentation, not commercially available, is a valuable asset to ORF, and to its clients. As indicated earlier in this report, research has shown that under certain conditions methanol may be used as an economical substitute for a portion of the fuel used to power diesel engines. The amount of methanol that can be successfully blended with the diesel fuel depends on the instantaneous operating conditions of the engine, particularly its r.p.m. and load. Experimental tests have been conducted at the ORF's Centre for Alternate Fuel Utilization to determine the optimum mixtures for a specific truck engine. Part of this test program involved the development and construction of a prototype electronic controller by ORF's Microelectronics and Instrumentation Group. Subsequently, this controller was tested successfully with the engine coupled to a dynamometer.



A highly flexible energy meter, designed and constructed by ORF, can be adapted to many applications.

Following these tests, a printed circuit board version was designed and constructed capable of withstanding the rigorous conditions of on-the-road testing. Several models of these devices have now been constructed and utilized in actual transport vehicles. To date, all the controllers have performed satisfactorily and future developments in this area are anticipated.

Product Design and Evaluation

Recently, Technifluids Limited of Calgary commissioned ORF to design and construct a high temperature and pressure circulatory system to be used for evaluating the rheological and filtration properties of drilling fluids under simulated downhole conditions.

Drilling fluids, called "muds", are vital to the drilling of oil, gas and thermal wells and typically 10% of the total drilling expenditures go to cover the cost of the muds. Pressures and temperatures increase dramatically with the depth of the bore hole. At a depth of 9,000 meters (5.6 miles), typically the pressure is 140,000 kPA (20,000 psi) and the temperature is 300°C.

After the development and analysis of many concepts, two distinct systems evolved. The first system, a viscometer system, permits the rheological properties of drilling muds to be determined over a wide range of temperatures, pressures and viscosities. Properties such as shear rate, shear stress, gel strength and viscosity can be accurately determined. The second system, a filtration system, closely simulates both static and dynamic downhole filtration conditions. The hydrodynamic flow conditions in the test apparatus can be controlled and a wide range of shear rates are obtainable. Interchangeable filter elements with a wide range of pore size and permeability can duplicate the properties of the different rock and shale formations.

Both systems are unique and significantly surpass in temperature range, pressure range, simulation and flexibility, any equipment known to exist. Both

systems are computer controlled with automatic sensing, monitoring, recording and display capabilities.

Another project, undertaken on behalf of Prevost Car Incorporated, a major North American coach manufacturer, involved ORF in their design and development program for an articulated bus suitable for highway operation.

Two theoretical and experimental analysis techniques, the Finite Element Method and Modal Analysis, were used by ORF on the articulated bus program. The Finite Element method was used to evaluate the structural integrity of a prototype bus design prepared by Prevost Car Inc. This method permitted the mathematical modelling of the individual tractor and trailer parts of the articulated bus to be considered in their entirety. Theoretical forces were applied to the F.E. models to simulate the more severe operating and emergency conditions encountered in service. The conclusions obtained enabled design recommendations to be made which resulted in improvements in passenger and driver safety and comfort, structural integrity, and ease of vehicle maintenance.

Subsequently, an experimental test program was carried out, firstly on a conventional vehicle to establish acceptable values of bounce and braking efficiencies with respect to passenger comfort, and secondly, on a prototype articulated bus to determine actual performance behaviour under the same loading conditions as those theoretically applied to the F.E. models.

The theoretical and the experimental results were in good agreement and gave assurance that any future considerations of operational loads, or design changes, can be readily assessed using the theoretical models.

A program undertaken for Bombardier Inc. of Valcourt, Quebec involved ORF in the Mexico City subway system. This company, Bombardier Inc. designs and produces rapid transit systems for major cities throughout the world.

ORF was contracted by Bombardier to perform life cycle or requalification tests on subway car components, including a bogie main frame for use on the Mexico City Metro System. To accommodate this test program it was necessary for ORF's mechanical design group to first design and assemble the necessary fixtures to contain the test frame, the load application system, and the monitoring system. The automatic loading, monitoring, recording and control of the test program on a continuous 24 hours/day basis was then programmed by ORF's instrumentation group, and strain gauges, load cells, etc. attached to measure applied forces and displacements. A safety system was also incorporated to shut down the rig and identify the location in the event of failure.

Both dynamic and static testing of the bogie main frames were then conducted on the new test facility. Several million cycles were applied without failures occurring.

"Mewac" (Manikin Extreme Weather Apparel Comparator) is a recently developed system for evaluating the protection of apparel to extreme temperatures

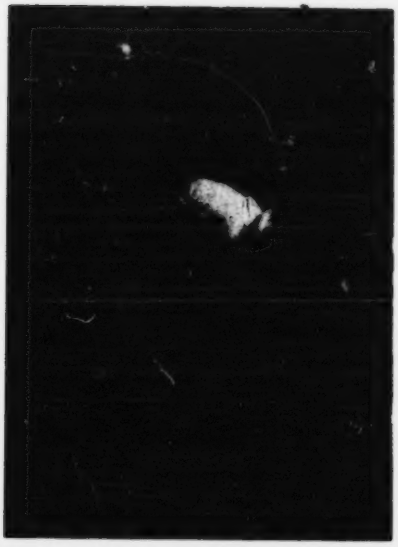
Productivity

The Industrial & Management Services Group introduced a seminar series on production management techniques and application in 1982. Five sessions were delivered locally and out-of-town to groups of businessmen in small and medium-sized secondary manufacturing companies. This three-day seminar, which is designed to accommodate from 12 to 20 participants in each offering, incorporates the unique feature of a no-charge, one-day visitation with each company. This visit is conducted under the auspices of the National Research Council-sponsored IRAP—C Field Advisory Services.

Subjects covered under the Production Management Seminar program include production planning, scheduling and control, quality assurance, inventory control, costing, motivation, organization, decision-making, time management, communication and productivity. The program is particularly pertinent to those without formal training in production management techniques.

This program will be continued and possibly expanded in 1983. Supplemental seminars under development include subjects such as: Product Development, Quality Assurance, Mini-Computers for Small Businessmen and Productivity Improvement.

Resources



On-site drilling for 12-inch asbestos core samples at a rig in Alaska

Ontario Research continued to serve the resource based industries in 1982, although the level of activity was reduced because of the economic problems that these industries faced.

Mineral Processing

Pilot Plant #2 which was designed and constructed specifically to meet the increasing workload relative to the processing of asbestos ores and other non-metallic minerals, became operational during the early part of 1982.

This facility incorporates two distinctly separate areas: a clean laboratory environment for conducting bench-scale studies and materials characterization, and a high-bay, large-scale working area containing scaled down commercial equipment for process development work. The latter area is maintained under negative pressure to prevent exfiltration of dusts to the outside or other working areas. In addition, a clean working environment is maintained inside the Plant by the use of extraction ports at all major processing stages where dust generation might occur.

In collaboration with Watts, Griffis and McOuat Limited, work continued on the development of a process flow sheet for the recovery of asbestos from a major ore body located in Alaska. This program which originated in 1978 is sponsored through Watts, Griffis and McOuat by a consortium consisting of G.C.O. Minerals Company, a subsidiary of International Paper Company and Tanana Asbestos Corporation, a subsidiary of Doyon Limited.

Initial stages involved the evaluation of various extraction methods, using small drill core samples cf the ore. In addition, process data were developed leading to the design of a flow sheet capable of processing large (12 inch diameter) drill core samples of the ore body.

The availability of the new Pilot Plant #2 then permitted the construction of a large-scale processing line capable of handling the 12 inch diameter drill core samples. By using "scaled-down" commercial equipment to process "burn-up" samples of the ore body, the finalization of a flow sheet to process the large drill core samples was greatly facilitated.

Hydrometallurgy

One of the more interesting projects in this general area concerns an assessment of the effect of specific techniques used for the disposal of uranium tailings on the volume and quality of run-off and seepage effluents. This project involves the long-range monitoring of high grade uranium mill tailings in three different scenarios.

The first scenario related to the effluents produced during uranium mill operations. This was accommodated by processing a Northern Saskatchewan uranium ore rich in arsenic in a pilot plant, and feeding the tailings to a specially designed (Knight and Piesold) tailings bed.

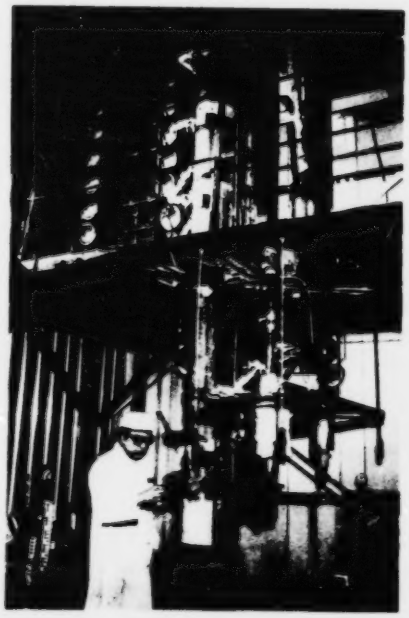
The second scenario related to the situation during a uranium mill shutdown. To accommodate this situation, the pilot plant operation was shut down, but the tailings effluent treatment circuit was kept running. Simulated climatic conditions were introduced into the tailings facility to match normal Northern Saskatchewan conditions, accelerated to condense a normal five years into a one year period.

The third scenario, now underway, is consistent with a mill and tailings abandonment situation. Again, simulated accelerated Northern Saskatchewan weather conditions in this tailings facility are being maintained.

In all cases, of course, all relevant parameters in the mill operations, the bed conditions, and the various effluents have been carefully monitored. The findings of this study will be of great significance to future programs dealing with the management and disposal of uranium tailings.

Fuel Resources

With the increasing costs and decreasing supplies of natural (non-renewable) petroleum resources, attention is being directed to coal as an alternative fuel resource. Canada's coal resources are relatively abundant, but much work needs



To gain a better understanding of the flash hydropyrolysis process, ORF has installed an FHP pilot unit

Simulated climatic conditions were introduced to a pilot scale uranium tailings bed, and five years' weather condensed to one.

to be done to convert these coals into more convenient fuel and chemical feedstocks.

One direct, high-temperature and pressure process to convert coal into more convenient gaseous and liquid fuels and chemical feedstocks is called the Flash Hydropyrolysis (FHP) process. This process is essentially a rapid reaction between pulverized coal and preheated hydrogen to obtain a range of products and char. To gain a better understanding of this technology and to collect data on Canadian coals, ORF has installed a FHP Pilot Unit under subcontract with Kilborn Ltd. This unit was designed by Kilborn for CANMET and is presently located in ORF's main Pilot Plant.

Another fuel resource found in abundance in Canada is peat. Although peat bogs cover about twelve percent of Canada, the potential of peat as a fuel resource has not been exploited because of the ready availability of other fuels. The extraction of energy and component materials from this immense resource has been an ongoing activity at ORF for many years, and has led to the development of a new process for extracting a commercially attractive waxy constituent from this material, as well as providing a good basic understanding of its potential as a fuel. On behalf of CANMET and the National Research Council, studies have been undertaken to develop a system for extracting energy from peat through a combination of wet-air oxidation and anaerobic digestion and also to produce a solid peat fuel through autothermal partial wet oxidation methods.

Waste Utilization

The feasibility of using wet-air oxidation technology for the conversion of agricultural residues to fermentable sugars, which had been studied in 1979-80, was applied in 1982 to the utilization of corn stover. A process flow-sheet incorporating wet-air oxidation was first developed and a program supported by Agriculture Canada, is being undertaken. The results so far appear promising.

Another waste material that has been the subject of study for some years is the ash that is produced in large quantities by coal-burning electricity generating stations. About five million tonnes of this ash are produced each year by Canadian electrical utilities, of which only fifteen percent is currently being utilized.

On behalf of the Canadian Electrical Association R & D program, an in-depth study has been conducted to develop strategies for the increased utilization of the ash from coal combustion. Critical reviews of potential markets indicate several options. Conventional low-value bulk applications for the material include its use in structural fill, cement and concrete, soil and waste stabilization, brick and lightweight aggregates, etc. Alternatively, some ashes may be beneficiated to recover resource components such as activated carbon, magnetite, cenospheres, and specification fillers; this approach would bring the material into higher value markets and would also allow considerable flexibility in the sale of a product mix. The use of ash for waste water treatment, agriculture, metals recovery, glass and ceramics, and ferrosilicon production has also been proposed, but further research and development is required.

In support of this approach to ash utilization and marketing, the study also included a technical evaluation of coal ash as a source for meeting these multiple end uses. Relevant standards, specifications and test methods were reviewed and incorporated into a laboratory testing manual to be used by utilities. Also, for illustrative purposes, ash from six Canadian power stations were evaluated.

During the course of the project, a complex balance of technical, institutional, and marketing factors were identified as inhibiting the progress of ash utilization in Canada. Major recommendations were directed to the industry as a whole for a coordinated approach to overcoming the barriers.

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Consolidated Statement of Income and Deficit
for the year ended December 31, 1982

	1982	1981
Income		
Professional services	$13,719,324	$12,565,303
Performance grant from the Province of Ontario (note 5)	4,347,500	3,428,000
Interest and dividends	244,637	588,472
Other	135,284	140,785
	18,446,745	16,722,560
Expense		
Salaries	10,290,652	9,583,788
Employees' pension and other benefits	754,483	774,952
Other direct project costs	3,903,313	3,300,642
General	1,978,888	2,017,242
Depreciation	1,842,110	1,429,716
	18,769,446	17,106,340
Loss for the year	322,701	383,780
Deficit, beginning of year	622,504	238,724
Deficit, end of year	$ 945,205	$ 622,504

Auditors' Report

To the Board of Governors of Ontario Research Foundation

We have examined the consolidated balance sheet of Ontario Research Foundation as at December 31, 1982 and the consolidated statements of income and deficit and changes in financial position for the year then ended. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests and other procedures as we considered necessary in the circumstances.

In our opinion these consolidated financial statements present fairly the financial position of Ontario Research Foundation as at December 31, 1982 and the results of its operations and the changes in its financial position for the year then ended in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Toronto, Canada
March 16, 1983

ALLEN, MILES, FOX & JOHNSTON
Chartered Accountants

Consolidated Statement of Changes in Financial Position

for the year ended December 31, 1982

	1982	1981
Source of working capital		
Operations		
Loss for the year	$ 322,701	$ 383,780
Charges to operations not affecting working capital		
Depreciation	1,842,110	1,429,716
Loss on disposal of equipment under capital lease	101,296	-
	1,620,705	1,045,936
Net decrease in investments	423,392	857,844
Fixed asset contributions (note 5)	361,000	2,389,000
Proceeds of sale of equipment under capital lease	180,000	-
Long-term portion of bank loan	-	465,000
	2,585,097	4,757,780
Use of working capital		
Cost of construction	194,833	2,579,330
Acquisition of apparatus and instruments (net)	716,484	2,213,253
Acquisition of other fixed assets (net)	121,773	433,380
Reduction of obligation under capital leases	341,720	124,314
Reduction of long-term portion of bank loan	400,000	-
	1,774,810	5,350,277
Increase (decrease) in working capital	810,287	(592,497)
Working capital, beginning of year	2,198,910	2,791,407
Working capital, end of year	$3,009,197	$2,198,910

Consolidated Balance Sheet
as at December 31, 1982

	1982	1981
Assets		
Current Assets		
Short-term deposits	$ 1,083,190	$ 608,750
Accounts receivable	3,347,907	3,729,082
Accrued interest receivable	16,022	16,371
Inventory of stores	80,939	87,568
Prepaid expenses	83,889	60,835
	4,611,947	4,502,606
Investments (note 2)	1,359,665	1,747,761
Fixed Assets (note 3)	14,435,966	15,526,282
	$20,407,578	$21,776,649
Liabilities		
Current Liabilities		
Bank overdraft	$ 18,597	$ 53,528
Accounts payable and accrued liabilities	1,054,670	1,613,725
Amounts received in advance for research and other projects	289,483	272,128
Current portion of long-term debt (note 4)	240,000	364,315
	1,602,750	2,303,696
Long-Term Debt (note 4)	360,000	1,101,720
	1,962,750	3,405,416
Capital		
Capital Funds		
Cash contributions		
Province of Ontario	5,316,525	5,316,525
Industry	2,433,675	2,433,675
	7,750,200	7,750,200
Fixed Assets Contributions (note 5)	7,108,601	6,747,601
Capital Surplus	2,480,376	2,480,376
Appropriated Surplus	375,000	375,000
Accumulated Net Gain on Realization of Investments	1,675,856	1,640,560
Deficit	(945,205)	(622,504)
	10,694,628	10,621,033
	18,444,828	18,371,233
	$20,407,578	$21,776,649

Approved on behalf of the Board of Governors

H. HOFMANN **W. STEVEN**

Notes to Consolidated Financial Statements
December 31, 1982

1. Summary of Significant Accounting Policies

A. Principles of Consolidation

These consolidated financial statements include the accounts of Ontario Research Foundation and its wholly-owned subsidiary, Ordco Technology Limited.

B. Inventory of Stores

Inventory of stores is valued at the lower of cost and replacement cost.

C. Fixed Assets and Depreciation

Fixed assets are stated at cost. Depreciation is provided on a straight line basis at the following annual rates:

Buildings	3.3% and 5%
Equipment	6 2/3%, 10% and 15%
Automotive equipment	33 1/3%

D. Pension Plan

An amount of $375,000 has been appropriated to December 31, 1982 to provide for anticipated improvements to the Improved Retirement Plan on March 1, 1985.

2. Investments

	1982	1981
Bonds, at amortized cost		
Government, direct and guaranteed	$ 491,317	$ 682,349
Public utility	101,032	127,131
Industrial and other	77,995	102,923
Common stocks, at cost	689,321	835,358
	$1,359,665	$1,747,761
Quoted market value	$1,772,527	$1,916,603

3. Fixed Assets

	1982			1981
	Cost	Accumulated Depreciation	Net	Net
Land	$ 597,438	$ -	$ 597,438	$ 597,438
Buildings	12,026,302	3,943,668	8,082,634	8,359,234
Equipment	13,648,639	7,913,754	5,734,885	6,110,597
Automotive equipment	91,092	70,083	21,009	37,737
Equipment under capital leases	-	-	-	421,276
	$26,363,471	$11,927,505	$14,435,966	$15,526,282

4. Long Term Debt

	1982	1981
Bank loan, bearing interest at the rate of 1/8% below the prime rate without specific terms for principal repayment. It is the intention of Ontario Research Foundation to repay the loan principal at a rate of $20,000 per month	$ 600,000	$ 1,000,000
Obligation under capital leases	-	466,035
	600,000	1,466,035
Less portion included in current liabilities	240,000	364,315
	$ 360,000	$ 1,101,720

5. Grants from the Province of Ontario

In 1982, Ontario Research Foundation received from the Province of Ontario grants totalling $4,708,500 of which $4,347,500 has been allocated to income and $361,000 to fixed asset contributions.

6. Contingent Liabilities

A. A claim in the amount of $50,000,000 has been made against Ontario Research Foundation and eight other defendants alleging unlawful conspiracy among the defendants.

B. A claim for damages alleging negligence in approving the safe use of urea formaldehyde has been made against Ontario Research Foundation and thirteen other defendants.

Ontario Research Foundation is disputing these claims and has instructed its solicitors to defend its position. The extent of the losses, if any, and the legal fees associated with these claims cannot be estimated at this time.

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Assistance to Outside Organizations

More than 50 staff members of Ontario Research served on various boards and committees of the following organizations during 1982:

Air Pollution Control Association
American Association of Textile Chemists and Colorists
American Powder Metallurgy Institute
American Society of Brewing Chemists
American Society of Heating, Refrigeration and Airconditioning Engineers
American Society for Testing and Materials
Association of Official Analytical Chemists
Association of Professional Engineers of Ontario
Association of Provincial Research Organizations

Board of Trade of Metropolitan Toronto

Canada/Commission of European Communities
Canada Association of Textile Colourists and Chemists
Canadian Carpet Institute
Canadian Ceramic Society
Canadian General Standards Board
Canadian Geotechnical Society
Canadian Institute of Mining and Metallurgy
Canadian Manufacturers' Association
Canadian Pulp and Paper Association
Canadian Research Management Association
Canadian Society for Industrial Engineering
Canadian Society for Professional Engineers
Canadian Standards Association
Canadian Uranium Products
Chemical Institute of Canada
Construction Safety Association of Ontario
Council on Protective Equipment

Eurogypsum-Working Community of the European Gypsum Industry

George Brown College of Applied Arts and Technology

Health and Welfare Canada

Institute of Textile Science
Institution of Production Engineers
International Confederation for Thermal Analysis
International Mineralogical Association
International Organization for Standardization
International Society for Industrial and Hazardous Waste

Journal of Thermal Analysis

National Fire Protection Association
National Research Council of Canada
National Sanitation Foundation
Occupational Hygiene Association of Ontario
Ontario Association of Certified Engineering Technicians and Technologists
Ontario Ministry of the Environment
Ordco Technology Limited
Organization for Economic Cooperation and Development

Pollution Probe

Réunion Internationale des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions (RILEM)
Royal Commission on Asbestos

SATRA-North America Research Inc.
Sheridan College of Applied Arts and Technology
Sheridan Park Association
Society of Research Administrators Canada
Source Evaluation Society

Technical Association of the Pulp and Paper Industry
Textile Society of Canada
Textile Technical Federation of Canada
Thermal Analysis Abstracts

Underwriters' Laboratories of Canada
University of Toronto, Faculty of Forestry

Wetcom Engineering Limited

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